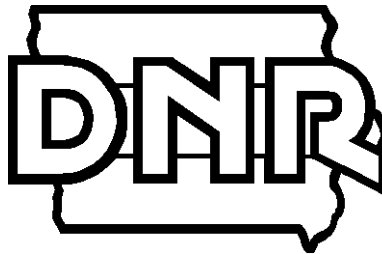


Draft Total Maximum Daily Load  
For Siltation  
Fairfield Municipal Reservoir 2  
Jefferson County, Iowa

May 2001

Iowa Department of Natural Resources  
Water Resources Section

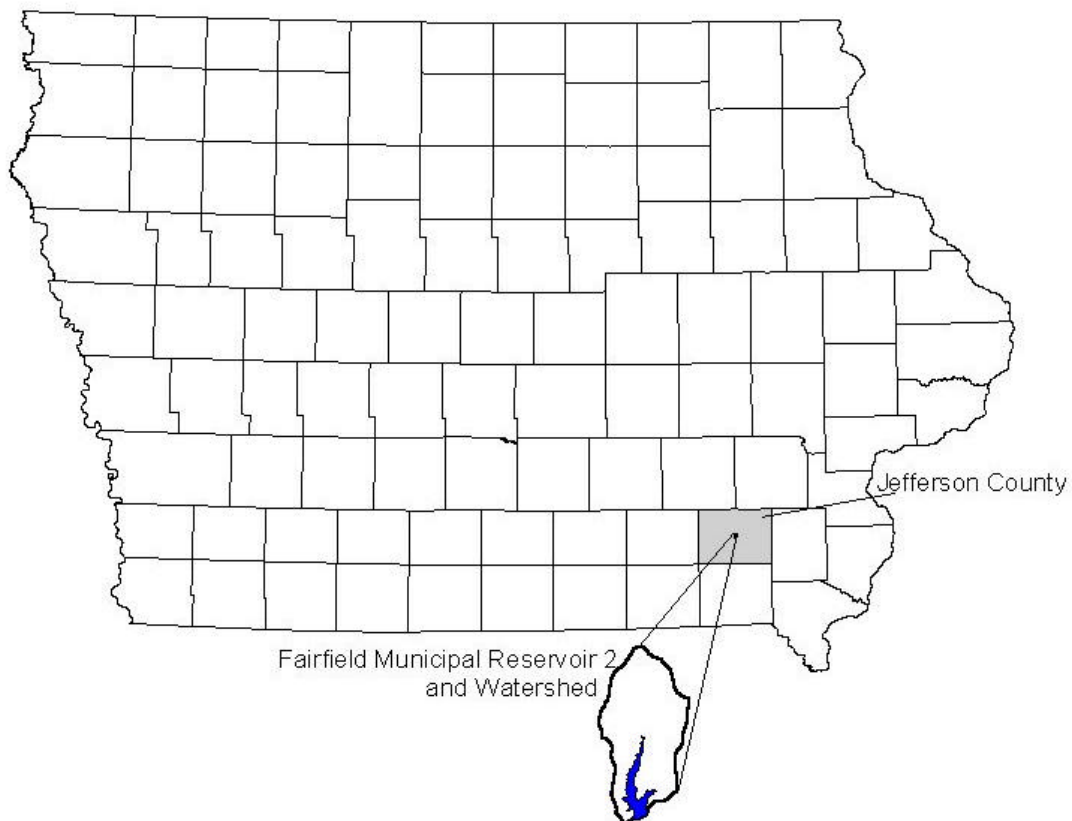


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# Draft TMDL for Siltation Fairfield Municipal Reservoir 2 Jefferson County, Iowa

Waterbody Name:	Fairfield Municipal Reservoir 2
IDNR Waterbody ID:	IA 03-SKU-00955-L
Hydrologic Unit Code:	HUC11 07080107040
Location:	Sec. 24 T72N R10W
Latitude:	41 Deg. 01 Min. N
Longitude:	91 Deg. 56 Min W
Use Designation Class:	B(LW) (aquatic life) C (potable water source)
Watershed Area:	596 acres
Lake Area:	54 acres
Major River Basin:	Skunk
Tributaries:	Unnamed intermittent streams
Pollutant:	Siltation
Pollutant Sources:	Agricultural Non Point Sources
1998 303d Priority:	High



## 1. Description of Waterbody and Watershed

Fairfield Municipal Reservoir 2 was built in 1898 and is located in southeastern Iowa, northeast of Fairfield, Iowa. Reservoir 2 is owned by the City of Fairfield. The designated use classes for Reservoir 2 are Class B (LW) (aquatic life) and C (potable water source). Fairfield Municipal Reservoir 2 has a shoreline length of 2.5 miles and a volume of approximately 390 acre-feet (Sperflage, 2000).

Fairfield Municipal Reservoir 2 is a standby source of potable water for the City of Fairfield. The Reservoir is also used for fishing, picnicking and boating and a trail system is being constructed around the lake. Fairfield Municipal Reservoir 2 is used frequently by local residents for these activities.

The Fairfield Municipal Reservoir 2 watershed has an area of approximately 596 acres and a watershed to lake ratio of 11:1. Land use data for the Fairfield Municipal Reservoir 2 watershed was collected in November 2000 by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, and the Iowa Department of Natural Resources staff. The land uses and associated areas for the watershed are shown in Table 1.

**Table 1.** Land use in the Fairfield Municipal Reservoir 2 watershed (November, 2000).

Land Use	Acres	Percent
Row crop	474	80%
Forest	47	8%
Grass / Hay	30	5%
CRP	37	6%
Roads, Farmsteads, etc.	8	1%
Total	596	100%

The watershed of Fairfield Reservoir 2 is dominated by agricultural row crop uses. The remainder of the land use is forest or grassland. Thirty-seven acres of row crop land were enrolled in the Conservation Reserve Program after the 2000 harvest. This reduced the percent of row crop acres in the watershed from 86% to 80%.

Topography of the watershed varies from level to gently sloping (0-14%). Soils of the watershed were developed from glacial till or loess and include Mahaska, Otley, Clarinda, and Taintor. These soils are moderately well to poorly drained and the permeability varies from moderate to very slow. These types of soils present slight to moderate erosion hazards (USDA, 1999)

Average rainfall in the area is 36 inches/year, with the greatest monthly amount (5.1 inches) occurring in July.

## 2. Applicable Water Quality Standards

The State of Iowa does not have numeric water quality standards for siltation. In 1992, the fishable uses (Class B) were assessed as partially supporting based on the best professional judgement of DNR Fisheries staff. The Reservoir has not been reassessed since 1992, rather the assessment of partially supporting of Class B (LW) has continued to be used. Siltation is causing impairments of the following beneficial uses: 1) aquatic habitat; 2) spawning, reproduction and development; and, 3) sport fishing. In addition, siltation reduces food supplies by smothering benthic macroinvertebrates.

### **3. Water Quality Conditions**

The water quality of Fairfield Reservoir 2 has not been well documented. As part of the Fairfield Lakes Water Quality Project, water samples were collected monthly from the lake from June 1998-July 2000 (Sperflage, 2000). This analysis was determined by field test methods and included turbidity, pH, total alkalinity, and total hardness (Sperflage, 2000).

### **4. Desired Endpoint**

The listing of Fairfield Reservoir 2 is based on narrative criteria. There are no numeric criteria for siltation applicable to Fairfield Reservoir 2 or its sources in Chapter 61 of *the Iowa Water Quality Standards* (IAC, 1996). Therefore, an appropriate endpoint for siltation needs to be determined. To help in this determination, a Clean Lake Restoration Project recently completed by the IDNR Fisheries Bureau (Bonneau, 1999) was reviewed. A primary component of the lake restoration project included a reduction in the amount of sediment delivered to the lake. AGNPS modeling predicted that the structures and management practices put in place reduced sediment delivery by 50%. The report concludes that as a partial result of the lake restoration and improved water quality, park usage tripled after the restoration was complete.

GIS modeling estimates the potential gross sheet and rill erosion for Fairfield Municipal Reservoir 2 at 4,926 tons/year. This modeling is based on the Revised Universal Soil Loss Equation (RUSLE) and takes into account worst case scenarios for soil losses. The model uses 1992 land use data with no best management practices in place. Manual calculations of potential gross sheet and rill erosion (based on RUSLE and 1992 conditions) for the watershed are estimated at 5,311 tons/year (Appendix I).

The estimated sediment delivery to Fairfield Municipal Reservoir 2 based on 1992 conditions is 1,913 tons/year. The desired endpoint for this TMDL is to reduce the 1992 sediment delivery to the reservoir to 957 tons per year (1.6 tons/acre/year average), which corresponds to a 50% reduction. This reduction is based on conditions that were present when the assessment was completed on Fairfield Municipal Reservoir 2 in 1992, versus the current land use and practices of the watershed.

In addition, this reduction in sediment delivery would result in an increased lake life from 400 years in 1992, to 800 years. This reduction in sediment delivery would restore water quality to fully support the Class B(LW) designated use. This endpoint relies on best professional judgement based, in part, on experience with the Clean Lakes Program.

### **5. Loading Capacity**

The Iowa DNR has restored several lakes as part of the Clean Lakes program. These prior restorations have shown that reducing sediment delivery by 50% will allow the lakes to achieve the necessary water quality needed to fully support their designated uses (Bonneau, 1999). These restorations have also shown that an increase in water clarity will increase the visitor use of the lake. Reducing the amount of sediment delivered to the lake should improve the overall water quality of the reservoir. The Iowa DNR has determined, based on Bonneau's report (1999), that by reducing sediment delivery to Fairfield Reservoir 2 to 957 tons per year (1.6 tons/acre/year average), the water quality will improve, thus restoring the lake to water quality standards.

## **6. Pollutant Sources**

Water quality in Fairfield Municipal Reservoir 2 is influenced only by nonpoint sources. There are no point source discharges in the watershed.

Fairfield Reservoir 2 was assessed as partially supporting of the Class B (LW) use in 1992 due to siltation. Since this assessment, three watershed projects have worked with landowners to improve the land management and conservation practices in the watershed.

Soil losses in the watershed average 10 tons/acre/year of sediment on row crop acres not protected by terraces (Dave White, District Conservationist). When the 1992 assessment was made there were very few, if any, terraces in place in the watershed. The estimated sediment delivery to the lake at the time of the assessment was 1,913 tons per year.

Field investigations to determine landuses, cropping patterns, fertilizer use, conservation practices, livestock operations, gully erosion and shoreline erosion were made in May 2000. Agricultural row crop production is the primary land use in this watershed (80%).

Conservation practices in place in the watershed include terraces, grass waterways, contour cropping, no till, minimum till, organic farming, and nutrient and chemical management. Fertilizer use has been reduced as part of the Fairfield Lakes Water Quality Project. There are no animal feeding operations in the watershed.

During the field investigations in May 2000, one active gully was located on the west side of the reservoir. The majority of this gully was covered with vegetation. There was very little erosive activity in this gully, and sediment delivery to the lake from this gully would be minimal. There is also some minimal shoreline erosion in Reservoir 2.

## **7. Pollutant Allocation**

### **7.1 Point Sources**

There are no point discharges within the Fairfield Reservoir 2 watershed. Therefore, the Wasteload Allocation established under this TMDL is zero.

### **7.2 Non-Point Sources**

The non-point source discharges are originating from sheet and rill and shoreline erosion. Gross sheet and rill erosion was calculated for the watershed using the Revised Universal Soil Loss Equation (RUSLE) and sediment delivery to Fairfield Municipal Reservoir 2 was determined using the erosion and sediment delivery worksheet (USDA-NRCS, 1998). These calculations are shown in Appendix I. When Fairfield Municipal Reservoir 2 was assessed, the estimated average sediment delivery was 1,913 tons per year (3.2 tons/acre/year). The desired endpoint is to reduce this rate by 50%. The Load Capacity established under this TMDL is 957 tons per year delivered to the lake from the watershed (1.6 tons/acre/year). The Load Allocation established under this TMDL is 909 tons per year (Load Capacity - Margin of Safety).

### **7.3 Margin of Safety**

An explicit margin of safety has been incorporated into the Load Allocation by retaining 5% (48 tons per year) of the Load Capacity as a margin of safety. RUSLE uses conservative calculations to calculate the gross erosion. This provides an implicit margin of safety.

## **8. Seasonal Variation**

This TMDL accounts for seasonal variation by recognizing that (1) sediment loading varies substantially by season and between years, and (2) sediment impacts are felt over multi-year timeframes. Sediment loading and transport are predictable only over long timeframes. Moreover, in contrast to pollutants that cause short-term beneficial use impacts and are thus sensitive to seasonal variation and critical conditions, the sediment impacts in this watershed occur over much longer time scales. For these reasons, the longer timeframe (tons per year) used in this TMDL is appropriate.

It is expected that the majority of all erosion occurring in the Fairfield Reservoir 2 watershed occurs in the spring during periods of higher rainfall and in the fall after crops have been harvested and the ground is left uncovered (Sperfslage, 2000).

## **9. Implementation**

The Iowa Department of Natural Resources recognizes that an implementation plan is not a required component of a Total Maximum Daily Load. However, the IDNR offers the following implementation strategy as a guide to improve water quality in Fairfield Municipal Reservoir 2.

This TMDL is being designed as a Phased TMDL with two Phases. Phase One of this TMDL is to reduce the amount of sediment delivered to the reservoir so that the Load Allocation is met. Phase Two is to reassess the fishery of the reservoir to determine if aquatic life impairments continue to exist.

The watershed of Fairfield Municipal Reservoir 2 is primarily agricultural and varies from level to gently sloping. Row crop accounts for 80% of the landuse in the watershed. Three watershed management projects have been sponsored by the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation and the Jefferson County Soil and Water Conservation District, beginning in 1990. The most recent project began in April 1998 and was completed in September 2000. These projects have resulted in the construction of erosion control structures and the improved management of the land.

All cropland acres in the watershed follow a USDA-NRCS plan and are usually a corn-bean rotation. Approximately 85 acres are consistently no-tilled, 67 acres now organically farmed, and the remainder of the cropland is minimum tilled (~30% residue left after planting).

During the watershed projects, approximately 20,000 feet of terraces have been constructed. There has also been a general reduction in fertilizers and long-lived herbicides, with fertilizer management now complete on 203 acres. In addition, there are approximately 2,000 feet of grass waterways in the watershed.

Shoreline erosion is present, but not extensive, in Reservoir 2. The Fairfield Lakes Water Quality Project addressed this erosion by placing riprap along selected portions of the eroding areas of shoreline (approximately 300 feet). In addition, willow stake plantings have been established to control bank sloughing in areas of the shoreline where it is not accessible to place riprap (approximately 425 feet of shoreline).

Very little of the Reservoir 2 watershed exists that still needs conservation measures implemented. There are approximately 21 acres on the west side of the lake that would benefit from the construction of terraces. This land is currently contour farmed and has minimum till practices in place. This tract may be developed for residential housing, therefore has not had

terraces constructed. Another 62 acres northwest of the reservoir would benefit from the construction of terraces. This land is currently organically farmed and minimum tilled.

Any future development in the watershed should ensure that erosion control practices are in place during construction, septic systems and leach fields are adequately designed and do not discharge to the lake, and future storm water runoff is adequately controlled to reduce sediment delivery to the lake.

The Fairfield Municipal Reservoir 2 currently has many best management practices and erosion control structures in place. With these conservation measures accounted for, the sediment delivery to the reservoir is expected to be 698 tons per year (1.2 t/a/y) based on the RUSLE and the erosion and sediment delivery worksheet (USDA-NRCS, 1998) (Appendix I). This equates to a 64% reduction in sediment delivery to the reservoir. The lake life of Fairfield Municipal Reservoir 2 has also been increased from 400 years in 1992, to nearly 1100 years with current land use and practices in place. Current conservation practices have already reduced sediment delivery to Fairfield Municipal Reservoir 2, and attained the desired endpoint of 957 tons per year. Phase One of this TMDL is considered complete.

Phase Two will be completed by the Fisheries Bureau of the Iowa Department of Natural Resources. The fishery at Fairfield Municipal Reservoir 2 will be surveyed by December 2002 to assess the Class B uses.

## **10. Public Participation**

Public meetings were held in Des Moines and Fairfield regarding the proposed TMDL for siltation for Fairfield Municipal Reservoir 2 on January 17 and January 25, 2001. A second public meeting will be held to present the Final Draft TMDL to the public. Any comments received will be reviewed and given consideration and, where appropriate, incorporated into the TMDL.

## **11. References**

Bonneau, Don. Phase II Project Final Report for Lake Ahquabi, Warren County, Iowa. 1999.

IAC. 1996. *Iowa Administrative Code 567, Chapter 61, Iowa Water Quality Standards*.

Sperflage, Thomas J. Fairfield Lakes Water Quality Project – Final Report. September 2000.

USDA-NRCS. 1998. Field Office Technical Guide Notice No. IA-198. "Erosion and Sediment Delivery Procedure", Section I, Erosion Protection.

USDA-NRCS. 1999. United States Department of Agriculture, Natural Resource Conservation Service. 1999. Soil Survey of Jefferson County, Iowa, Parts I and II.



## APPENDIX I

### Sediment Delivery to Fairfield Reservoir 2:

1992 Landuse and Conservation practices

Landuse	Acres	Gross Erosion Rate (t/a/y)	SDR	Sediment Delivered (tons)
Row crop	511	10	36%	1,840
Grass/hay	30	2	36%	22
Forest	47	3	36%	51
Total Delivery per year (tons)				1,913

2001 Landuse and Conservation practices

Landuse	Acres	Gross Erosion Rate (t/a/y)	SDR	Sediment Delivered (tons)
Row crop (not terraced)	83	10	36%	299
Row crop (terraced)	391	4	20%	313
CRP	37	1	36%	13
Grass/Hay	30	2	36%	22
Forest	47	3	36%	51
Total Delivery per year (tons)				698

Gross erosion rates for row crop land in the Fairfield Reservoir 2 watershed were obtained from the local NRCS office.

The SDR (Sediment Delivery Ratio) was obtained from the Erosion and Sediment Delivery Worksheet, (NRCS) and is based on the drainage area of the watershed, watershed shape, topography, channel density, channel characteristics, and type of drainage.

### Lake Life Determination:

Lake Volume = 390 acre-feet (16,988,400 ft<sup>3</sup>)

1 ft<sup>3</sup> of sediment = 0.045 tons

Sediment Delivery = tons/year / 0.045 tons/ft<sup>3</sup>

Lake Life = Lake Volume / Sediment Delivery

Sediment Delivery	Lake Life (years)
698 tons / year	1095
957 tons / year	800
1913 tons / year	400

Fairfield Reservoir 2 and watershed

